

A SYNOPSIS OF THE FAMILY VENERIDÆ. PART I.

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Read 12th December, 1913.

DURING the course of the past eight years I have collected and studied the members of this family, both recent and fossil, and the results of my studies of some of the generic groups have been communicated to this Society from time to time. I have now prepared a general synopsis of the whole family in order to record my final views on the affinities and taxonomic values of the numerous groups, generic and sub-generic, which have been recognized by different writers at various times.

The family is a large one, and has generally been divided into three or four tribes or sub-families. Thus Deshayes, in 1853, made four such divisions which he called *Dosiniana*, *Meretriciana*, *Venusina*, and *Tapesina*.¹ Fischer, in 1887,² only recognized three such tribes, viz. *Meretricinæ*, *Venerinæ*, and *Tapetinæ*; but Dr. Dall, in 1902, again proposed to make four sub-families, viz. *Dosininæ*, *Meretricinæ*, *Venerinæ*, and *Gemminæ*. He rightly considered that the distinction between *Venerinæ* and *Tapetinæ* could not be maintained; but in my opinion the same must be said of the supposed distinction between *Dosininæ* and *Meretricinæ*, for the difference between the shells of *Dosinia* and *Pitaria* is very small, and there is probably quite as little difference between the animals. The two genera are linked together by the sub-genera which have been described by M. Cossmann and myself under the names of *Sinodia* and *Cordiopsis*.

With respect to the *Gemminæ*, they are separated by Dr. Dall because their embryos are incubated by retention within the mantle-cavity, as in the case of *Sphærium* and *Pisidium*. He calls this viviparous reproduction, but the term is hardly correct, for, as Professor Pelseneer has remarked, "there are no viviparous Lamelli-branches, though a certain number of them appear to be so because they are incubators." The fact that *Gemma*, *Parastarte*, and *Psephidia* protect their young in this way is interesting, but it does not follow that they are closely related in other respects, and we know so little about the developmental arrangements of other genera that it seems unnecessary at present to separate these groups from those which seem to be their nearest allies. For instance, the shell of *Psephidia* closely resembles that of *Gomphina*, and it is quite possible that *Gomphina* incubates its embryos: we simply do not know. Consequently I do not propose to recognize the *Gemminæ* as a distinct sub-family, believing that it is at present not convenient to make more than two such divisions, viz. the *Meretricinæ* and the *Venerinæ*.

I had hoped that the nomenclature of the various genera and sub-genera would have been settled before I set myself to draw up this

¹ Catalogue of the Conchifera in the British Museum, London, 1853.

² P. Fischer, *Man. de Conch.*, Paris, 1887.

synopsis, but unfortunately this is not the case. The strict application of the rule of priority has created many difficulties and absurdities which were not foreseen by those who drew up the International Code of Rules. A notable instance of such an irrational consequence of the existing rule is that of *Callista*, for if this name is abandoned the well-known group of shells which it connotes will have to take a subordinate place, the name *Macrocallista*, which was proposed for a small section of the genus, becoming the generic name, while the really typical group would receive the name of *Chionella*, with an Eocene fossil for its type instead of the well-known recent *Venus chione*, which has always been regarded as its typical example.

Again, if Bolten's Museum Catalogue is recognized as a scientific publication, and is not excluded from the law of priority, his names would supplant those of Lamarck, which have been in general use for a century or more. Moreover, Bolten's Catalogue gives no definitions of genera or sub-genera, and is absolutely devoid of any scientific value; while Lamarck's genera were properly discriminated and defined. I hold, therefore, that such a displacement of names is unjust, unnecessary, and inconvenient, and as the Zoological Congress has now resolved that exceptions may be made to the rule of priority I hope that Bolten's Catalogue may soon be declared an exception.

Meantime I refuse to be bound by the trammels of this rule in the strict fashion which some still advocate. I shall therefore retain the name *Callista* as used by Mörch in 1853 and by the Adams in 1857, ignoring its use by Leach in 1852 with a different signification which can never become operative. Similarly, I shall not accept the revived use of the names *Cytherea* and *Paphia*, as proposed by Dr. Dall, who adopts and adapts them from Bolten.

As I have described most of the fossil groups in previous papers it will suffice for my present purpose if I mention them in their proper places, with only brief notices of their chief characteristics. The most ancient genera appear to be *Callista*, *Dosiniopsis*, *Cyprimeria*, *Flaventia*, and *Baroda*, all of which are found in the Cretaceous deposits of Europe and India. *Pitaria* appears in the Eocene, and is probably the ancestor of *Dosinia*, which does not make its appearance till the Oligocene, and then only in America, the earliest European *Dosinia* being of Miocene date, though the sub-genus *Cordiopsis* occurs in the Oligocene.

Dosiniopsis does not seem to me to have any closer affinity to *Dosinia* than to *Callista*, but it is certainly related to *Sunetta* through the Eocene *Meroena*; the latter, indeed, might be regarded as a *Dosiniopsis* in which the posterior lateral teeth have been obliterated by the extreme depression of the posterior border.

With regard to the shells to which I gave the name of *Flaventia* in 1908, I am still of opinion that *Clementia* is their nearest living representative, but the group is really a comprehensive or less differentiated type, combining characters now found in *Clementia* and *Samarangia*. It may also have been the ancestor of *Venus* and *Chione*, but if so the links have not yet been discovered.

Sub-family MERETRICINÆ.

Genus CALLISTA, Mörch (after Poli).

The shells of this genus were included under *Meretrix* (= *Cytherea*) by Lamarek, but were recognized as a sub-genus by Mörch in 1853, and as a genus by the Adams in 1857. Having fully described this group of shells in a recent paper,¹ and having therein given my reasons for attaching to it as sub-genera the recent and fossil groups known as *Aphrodina*, *Tivelina*, *Transenella*, and *Lepidocardia*, I need hardly reprint all the descriptions there set forth, but shall merely give a generic description and enumerate the subordinate groups.

Type, *Venus chione*, Linn. (fixed by Meek in 1876).

Synonyms: *Chione*, Gray, 1838 (not Megerle); *Dione*, Gray, 1847 (not Hubner); *Chionella*, Cossmann, 1886.

Shell oval or elongate, smooth, striate or concentrically ridged. Lunule circumscribed, but escutcheon not defined. Hinge of left valve with a strong anterior lateral and three cardinals, of which the two anterior are united at the top, and the posterior is confluent with the nymph; in the right valve are two anterior laterals and three cardinals, of which the two anterior are near together. Right posterior margin always, and left anterior margin generally, grooved, the opposite margins being bevelled to fit into these grooves. Ventral margins smooth (except in *Transenella*). Pedal scar connected with that of adductor by a long narrow canal.

Section *Callista*, s.s. Type, *Venus chione*, Linn.

Surface glossy and vernicose, with minute discontinuous ingrained radial striæ. Pallial sinus wide, horizontal, and pointed in front. Right posterior cardinal narrow and superficially grooved.

Section *Macrocallista*, Meek (1876). Type, *V. nimbose*, Sol.

Section *Callistina*, J.-Br. (1908). Type, *Cytherea plana*, Sow. (Cret.).

Sub-genera.

Lepidocardia, Dall, 1902. Type, *Venus africana*, Phil.

Shell small, compressed, and posteriorly attenuated. Hinge short and teeth crowded.

Transenella, Dall, 1883. Type, *Cytherea conradiana*, Dall.

Pallial sinus rounded. Valve-margins tangentially grooved.

Tivelina, Cossmann, 1887. Type, *Cytherea tellinaria*, Lam.

Small and compressed. Cardinal teeth all short. Pallial sinus small, rounded, and ascending (Eocene).

Aphrodina, Conrad, 1868. Type, *Meretrix tippana*, Conr.

Cardinal teeth widely divergent. Pallial sinus deep, ascending.

Cretaceous and Eocene fossils.

Genus AMIANTIS, Carpenter, 1865.

Synonyms: *Dione*, Gray, 1847 (not 1851); *Dione*, Römer, 1862; *Dione*, Fischer, 1887; *Hysteroconcha* is pre-Linnæan.

¹ Proc. Malac. Soc., vol. x, p. 335, 1913.

Shell oval, concentrically ridged. Lunule impressed and circumscribed. Escutcheon generally defined, but narrow. Hinge like that of *Callista*, but the pit between the laterals of the right valve is continued into a channel which passes under the anterior cardinal. Pallial sinus deep and horizontal. Right posterior margin grooved, but not the left anterior. Pedal scar opening freely or by a short channel into that of the adductor.

Section *Amiantis*, s.s. Type, *Cytherea callosa*, Conrad.

Shell thick, glossy, and broadly ribbed over whole or part of surface. Hinge strong, with rugose nymphs. Pallial sinus generally pointed. This includes only three species, *A. callosa*, *A. umbonella*, Lam., and *A. purpurata*, Lam.

Section *Lamelliconcha*, Dall. Type, *Cytherea concinna*, Sow.

Shell concentrically ridged. Hinge-plate excavated and attenuated behind. Nymphs longitudinally striated. Pallial sinus obtuse or regularly rounded. The shells known as *Dione dione*, *D. lupanaria*, *D. rosea*, *D. circinata*, *D. unicolor*, and *D. cor* (Hanley) belong to this section.

Venus dione, Linn., ought to have been taken as the type of the *Lamelliconcha* section, but Dr. Dall was under the erroneous impression that Fischer had proposed the name *Hysteroconcha* with *V. dione* as its type, whereas he merely mentioned it as a synonym of Gray's *Dione*. Dall's *Lamelliconcha* only differs in the absence of spines, which I regard as a specific and not a sectional character.

GENUS PITARIA, Römer, 1857, em.

This genus was also fully discussed in the article above-mentioned, and reasons were given for establishing the two sub-genera to which I gave the names of *Callizona* and *Leucothea*, but it has been pointed out to me that both these names are preoccupied and I am consequently obliged to propose substitutes. For the former I propose *Tinctora* (from *tincta* and *ora*, a border), and for the latter *Aphrodora* (from *αφρος*, foam, and *δωρα*, a gift). I also separated a section under the name of *Pitarina*. By an oversight, however, the section *Agriopoma* was placed under *Amiantis*, instead of under *Pitaria*, where it properly belongs. The following is an amended synopsis of the genus:—

Synonym: *Caryatis*, Römer, 1862.

Shell oval or sub-trigonal, smooth or finely striate; lunule superficial; escutcheon not defined. Teeth of the left valve like those of *Amiantis*, but the posterior cardinal generally more or less separate from the nymph; in the right valve the two outer cardinals often united to form an arch over the median. Pallial sinus short and rounded. Right posterior and left anterior dorsal margins grooved as in *Callista*. Pedal scar confluent with that of adductor.

Section *Pitaria*, s.s. Type, *Venus tumens*, Gmel.

Nymphs longitudinally striated. Left posterior cardinal confluent with the nymph, median triangular; right cardinals separate. Pallial sinus deep and pointed.

Section *Calpitaria*, J.-Br., 1908. Type, *Cytherea sulcataria*, Lam.

Nymphs striated. Left posterior cardinal partly free and extending across the hinge-plate; left median triangular. Right cardinals separate. Pallial sinus short and rounded (Eocene to Recent).

Section *Pitarina*, J.-Br., 1913. Type, *Cytherea citrina*, Lam.

Nymphs smooth; left posterior cardinal wholly free and oblique; outer cardinals of right valve united at top to form an arch; pallial sinus short, rounded, and ascending.

Section *Agriopoma*, Dall, 1902. Type, *Cytherea texasiana*, Dall.

Shell dull white; nymphs smooth; left posterior cardinal long and partly free; outer cardinals of right valve forming a complete arch; pallial sinus sharply angular.

Sub-genera.

Tinctora, n.n., J.-Br., 1914. Type, *Cytherea vulnerata*, Brod.

Synonym: *Callizona*, J.-Br., 1913.

Shell thick, sub-orbicular, glossy; valve-margins crenulated; left posterior cardinal long and partly free from nymph; median very thick; pallial sinus short and rounded. Pedal scar as in *Callista*.

Callocardia, A. Adams, 1864. Type, *C. guttata*, A. Adams.

Shell very thin. Hinge-plate narrow and excavated between the teeth. Two cardinals in each valve, united to form complete curved arches. Left posterior cardinal long and free. Right posterior formed of two narrow plates. Pallial line believed to be entire.

Aphrodora, n.n., J.-Br., 1914. Type, *Callocardia birtsi*, Preston.

Synonym: *Leucothea*, J.-Br., 1913.

Shell thin, white. Hinge-plate short, curved, and narrowed posteriorly. Teeth thin and weak; left posterior short and confluent with the nymph, right outer cardinals forming a complete arch. Pallial sinus short and rounded.

Atopodonta, Cossm., 1886. Type, *Venus conformis*, Desh.

Shell small, but not thin. In the right valve the posterior cardinal consists of two separate plates, one of which is united to the anterior tooth, forming an arch over the median, which is bifid and Λ -shaped. Pallial line entire.

Genus LIOCONCHA, Mörch.

This genus was separated from *Circe* by Mörch in 1853 and was placed as a sub-genus of *Meretrix* by Fischer in 1887, but was adopted as a genus by Dr. Dall (1902). I agree with Dr. Dall's view of its taxonomic importance, for it is undoubtedly more nearly related to *Callista* than to *Circe*, and yet it differs from the former in several important particulars, as will be seen from the following definition.

Type, *Venus castrensis*, Linn.

Shell oval or sub-trigonal; smooth or concentrically ridged. Lunule superficial. Escutcheon not defined. Hinge-plate thick; teeth like those of *Callista*, but left posterior long and partly free from the nymph. Right posterior entire or feebly grooved. Dorsal margins grooved as in *Callista*. Pallial line entire. Pedal scar confluent with that of the adductor.

The genus includes two slightly different groups of shells; the one typified by *castrensis* is nearly smooth, the other typified by

trimaculata is finely striated or grooved, and more oblique in form, the posterior end being somewhat produced; the latter group includes *L. sulcatina*, Lam., and *Dione philippiana*, Hanley.

Genus SAXIDOMUS, Conrad, 1857.

The true position of this genus as a member of the Meretriciinae was established by Dr. Dall in 1902.¹ The anterior laterals are placed so near the anterior cardinals that they have been mistaken for supernumerary cardinals, and the shell has consequently been located near *Tapes* and *Venerupis*. It is, however, more nearly related to *Callista* than to any other genus, and is to some extent linked with *Callista* by the Japanese species *C. chishumana*, which has a corrugated shell and oblique anterior lateral teeth. The dentition of *Saxidomus* differs from that of *Callista* much in the same way as the hinge of *Dosinia* differs from that of *Pitaria*. The animal is said to have long and closely united siphons.

Only three living species of *Saxidomus* are known, namely, *S. nuttalli*, Conrad (= *aratus*, Gould, and *maximus*, Anton), *S. giganteus*, Desh., and *S. purpuratus*, Sow. They all come from the North Pacific, ranging from California northwards to Alaska and Japan. In time they go back to the Eocene of California.

Type, *S. nuttalli*, Conrad.

Shell oval, concentrically corrugated; without defined lunule or escutcheon; slightly gaping posteriorly. Ligament large and conspicuous. Hinge-plate curved and narrow, with irregular teeth; left valve with an oblique anterior lateral and three cardinals, which are narrow and near together, the posterior being separate from the nymph; right valve with two small anterior laterals and three cardinals, of which only the posterior is grooved. Valve-margins smooth and without any groove in either valve. Pallial sinus deep and horizontal. Muscular impressions large; pedal scar opening irregularly into that of the adductor.

Genus DOSINIA, Scopoli, 1777.

This genus and its subdivisions have also been fully discussed in a previous paper, to which the reader is referred.² Here, therefore, I need only give a generic definition and an abbreviated synopsis of the sections and sub-genera which I think worth recognition. The *Dosinorbis* of Dall was based on *D. bilunulata*, which has a defined area outside the true lunule; similar areas exist in *Chione roborata* and *Ch. calophylla*, and are only of specific importance. The sub-genera *Sinodia* and *Cordiopsis* may be regarded as links between the genera *Dosinia* and *Pitaria*.

Synonyms: *Orbiculus*, Megerle (1811); *Artemis*, Poli in Oken (1815); *Asa*, Leach in Basterot (1825); *Arctoe*, Risso (1826); *Exoleta*, Brown, 1827. Not *Dosina*, Gray (1838).

Shell sub-orbicular, more or less compressed, concentrically striated

¹ Proc. U.S. Nat. Museum, vol. xxvi, p. 356.

² Proc. Malac. Soc., vol. x, p. 95, 1912.

or corrugated. Lunule generally small and impressed. Escutcheon seldom well defined; ligament generally deeply sunk. Hinge-plate deep and strong; cardinal teeth 3-3, with one anterior lateral in the left and two small ones in the right valve; right posterior cardinal bifid, and often a supplementary tooth-like ridge at the base of the right nymph. Left posterior cardinal long and extending obliquely across the hinge-plate. Right posterior margin generally grooved for a short distance, but the left anterior only in *Sinodia* and *Cordiopsis*. Pedal scar confluent with that of the adductor.

Dosinia, s.s. Type, *D. africana*, Gray.

Escutcheon depressed. Anterior lateral large and strong. Left middle cardinal broadly bifid. Pallial sinus long, narrow, ascending.

Section *Dosinella*, Dall, 1902. Type, *D. angulosa*, Phil.

Lunule shallow. Escutcheon ill-defined. Anterior lateral small or obsolete; left middle cardinal broad and bifid. Pallial sinus very deep, ascending and rounded at the end.

Section *Austrodosinia*, Dall. Type, *D. anus*, Phil.

Escutcheon ill-defined. Anterior lateral strong and rugose. Left middle cardinal entire and solid. Pallial sinus short, horizontal.

Section *Phacosoma*, J.-Br., 1912. Type, *D. japonica*, Reeve.

Escutcheon well-defined by lamellose ridges, and the inner edges turned up on each side of the ligament. Anterior lateral strong and left median cardinal oblique, rugosely striated, but not bifid. Pallial sinus deep and angular.

Section *Pectunculus*, Da Costa (= *Orbiculus*, Megerle). Type, *D. exoleta*, Linn.

Escutcheon not defined. Anterior lateral small, and left middle cardinal obscurely and unequally bifid. Pallial sinus deep, ascending, rounded or obtusely angular.

Section *Dosinidia*, Dall, 1902. Type, *D. concentrica*, Born.

Escutcheon not defined and lunule very little impressed. Anterior lateral small and pustular. Left middle cardinal broad and obscurely bifid. Pallial sinus deep, angular, and ascending. Dorsal margins not grooved.

Sub-genera.

Sinodia, J.-Br. Type, *Dosinia trigona*, Reeve.

Shell convex. Lunule superficial, not impressed. Escutcheon not defined. Anterior lateral strong and distant. Middle left cardinal solid and central. Both left anterior and right posterior margins grooved for some distance. Pallial sinus rather short and rounded.

Since the publication of my paper on *Dosinia* I have discovered that *Cytherea gouldi*, Reeve, belongs to this sub-genus. The type is in the British Museum, and Mr. E. A. Smith writes that "it is certainly a *Sinodia*, the hinge being exactly the same as in *trigona*".

Cordiopsis, Cossmann. Type, *Cytherea incrassata*, Sow.

Shell thick, sub-orbicular, convex and cordiform, with prominent incurved umbones. No lunule or escutcheon. Left anterior lateral small and becoming obsolete with age; middle cardinal thick, rugose, and central. Left anterior and right posterior dorsal margins grooved. Pallial sinus short, sub-angular, ascending.

Pelecypora, Dall, 1902. Type, *Cytherea hatchetigbeensis*, Aldrich.

This shell seems to be distinguished by its rugose nymphs and narrow angular pallial sinus. It is a fossil from the Eocene of the United States.

Genus **DOSINIOPSIS**, Conrad, 1864.

Synonym, *Æora*, Conrad, 1870.

Type, *Cytherea lenticularis*, Rogers.

Shell sub-orbicular or rounded oval. Lunule indistinct. Escutcheon often defined and depressed. Cardinal teeth three in each valve, separate, divergent, and entire, except the right posterior, which is bifid. Left median strong, central, and triangular. Anterior lateral elongate, rugose, and a simple pit for its reception in the right valve; a single posterior lateral in each valve. Nymphs finely granulated. Dorsal margins not grooved. Pallial sinus rather short, ascending, rounded or sub-angular.

This genus is extinct, and is only known from fossil representatives in the Cretaceous and Eocene deposits. The Cretaceous species *D. subrotunda* and the Eocene *D. orbicularis* have sharply depressed escutcheons, and it is from them that *Meroena* and *Sunetta* have been derived.

Genus **SUNETTA**, Link, 1807.

At the present day this genus is specially characteristic of the Indo-Pacific region, but it extends round the Cape to the west coast of Africa, as far north as Senegal. In Eocene and Miocene times it lived in European seas, but no species has survived in the Mediterranean area. In eastern seas it ranges from Japan on the north to the coast of South Australia. The animal is unknown.

Synonyms: *Cuneus*, Megerle, 1811 (not Da Costa); *Meroe*, Schumacher, 1817.

Shell oval or sub-orbicular, sub-equilateral, rather thick, smooth or concentrically grooved, with obscure radial riblets. Lunule impressed and circumscribed; escutcheon narrow and deeply depressed. Cardinal teeth 3-3, straight, separate, and touching dorsal border; the medians fairly stout, the others narrow, and all generally entire; the left posterior confluent with the nymph. Anterior laterals strong, one in left and two in right valve. Right posterior and left anterior marginal grooves short or obsolete. Nymphs finely denticulate. Pallial sinus short, sub-angular, and horizontal. Ventral and lateral margins crenulated (except in *Meroina*). Pedal scar under hinge-plate and confluent with that of the adductor.

Sunetta, s.s. Type, *Donax scripta*, Linn.

Shell elongate-oval, compressed or inflated, either equilateral or posterior side the shorter. Left posterior cardinal short, right one smooth and entire.

Sunettina, Jousseaume, 1901. Type, *S. sunettina*, Jous.

Shell sub-orbicular, compressed; posterior side expanded and rather longer than the anterior. Left posterior cardinal long and thin, the right one grooved at the top.

I have not recognized the section *Solanderina*, created by Dr. Dall in 1902 for *S. solandri* (Gray) with the brief definition that it is "inflated, smooth, and sub-equilateral", because the convexity of the valves is really the only point of difference. *S. scripta* is just as smooth, *S. truncata* and *S. karachiensis* just as equilateral, and yet both are compressed. The internal characters of *solandri* are the same as those of the type: the only other species which could be classed with it is *S. neglecta*, Smith, but that is less inflated and is more nearly allied to *S. vaginalis*, which I should refer to the section *Sunettina*.

Sub-genus.

Meroina, J.-Br., 1908. Type, *Cytherea trigonula*, Desh.

Shell oval or sub-trigonal, but posterior side the longer. Escutcheon less deeply sunk, and borders less acute than in recent forms. Right posterior cardinal grooved. Anterior laterals short and distant from cardinals. Ventral and lateral margins smooth.

Genus *CIRCE*, Schumacher, 1817.

This genus dates from Eocene times through the sub-genera *Gouldia* and *Circenita*, but no representative of the typical section has yet been found earlier than the Oligocene. At the present day this group of shells is widely distributed over the whole world, but the typical section of *Circe* (s.s.) and the sub-genus *Crista* are only found in the tropical parts of the Indo-Pacific region.

Synonyms: *Paphia*, Oken, 1815 (not Lamarek); *Gafrarium*, Dall after Bolten, 1902.

Shell oval or sub-orbicular, with concentric or radiate sculpture or a combination of both. Lunule flat, long, and narrow; the escutcheon when defined is very narrow. Hinge-plate deep and triangular, with three straight, separate, and slightly divergent cardinal teeth in each valve. Right posterior dorsal margin always grooved, but on the left anterior side only the lunular margin is narrowly grooved. Lower margins smooth or crenulated. Pallial line entire or slightly sinuated. Pedal scar small, round, and separate from the adductor (except in *Gouldia*).

Circe, s.s. Type, *Venus scripta*, Linn.

Shell compressed and flattened at the umbones, with dominant concentric sculpture, but often divaricately ribbed on the dorsal margins or umbonal disk. Escutcheon very narrow, and ligament deeply sunk. Valve-margins smooth. Left posterior tooth long, the median bifid and rugose, the others entire. Pallial line entire. This typical section includes *plicatina*, *rivularis*, *undatina*, and var., *orbica*, *tumefacta*, *nummulina*, and *lirata*, Röm., but not *sulcata*, which belongs to *Gouldia*.

Parmulina, Dall, 1902. Type, *Circe corrugata*, Chem.

Shell thick, sub-orbicular, much flattened on the umbonal area, which is rugosely ribbed, the rest of the surface being concentrically sulcated or striated. Teeth generally more divergent. Ventral margins crenulated. Pallial line entire. So far as I can ascertain

only three species belong to this section, viz. *C. corrugata*, Chem., *C. crocea*, Gray, and *C. intermedia*, Rve. All of these live on the Arabian coasts from the Red Sea to the Gulf of Oman, and *crocea* ranges down the African coasts as far as Zanzibar, but I cannot learn that any of them have been recorded from India.

Sub-genera.

Crista, Römer, 1847. Type, *Venus pectinata*, Linnæus.

Synonyms: *Paphia*, Oken, 1815 (not Lam.); *Gafrarium*, Dall after Bolten.

Shell not flattened at the umbones, convex or compressed, with radial and concentric sculpture, the radials divaricate. Esecutiveon narrow and impressed, and the ligament sunken. Hinge-plate short and triangular. In the left valve the median cardinal is grooved, and the posterior is short. The margins of the valves are generally but not always crenulated. This group includes *C. gibbia*, Lam., *C. divaricata*, Chem., *C. æquivoca*, Chem., *C. dispar*, Chem., *C. cuneata*, Lam., *C. australis*, Sow., and *C. transversaria*, Desh. Typical *dispar* has smooth margins, while those of *cuneata* are crenulate; similarly, those of *transversaria* are smooth and of *æquivoca*, which it much resembles, are crenulate.

Circenita, Jousseaume, 1888. Type, *Circe arabica*, Chem.

Shell oval, convex, concentrically ribbed or striated, and without radial sculpture. Esecutiveon not defined, and ligament exposed. Cardinal teeth small, near together, and entire; the anterior laterals comparatively large. Ventral margins always smooth. Pallial line slightly sinuated. This is a very small group, including only three well-marked species, viz. *arabica*, Chem., *lentiginosa*, Chem., and *culppyga*, Born, but several varieties have been given names, such as *adenensis*, Phil., *pulchra*, Desh., *splendens*, Sow., *semiarata*, Dkr., and *funiculata*, Römer.

Gouldia, C. B. Adams, 1847. Type, *Circe cerina*, Adams.

Shell rather small, oval, convex, with dominant concentric sculpture, but sometimes having fine radial striation at the sides. Esecutiveon not defined. Teeth more widely divergent; right posterior cardinal grooved, but the rest entire. Posterior dorsal margins of both valves strongly grooved, each generally having a ridge and a groove. Ventral margins smooth or irregularly rugose (not crenulate). Pallial line slightly inflected. Pedal scar confluent with that of the adductor. This group includes *C. minima*, Mont. (Atlantic and Mediterranean), *C. bermudensis*, Smith (Bermuda and West Indies), *C. sulcata*, Gray (Red Sea to Philippines and Fiji), *C. nana*, Melv. (Persian Gulf to Siam), *C. melvilli*, Lyngé (Siam), and *C. amica*, Smith (Pacific Islands).

Meretrissa, Jukes-Browne, 1908. Type, *Tivelina depressa*, Desh. (fossil).

In 1908 I separated two species of small shells occurring in the Oligocene of the Paris Basin under the name of *Meretrissa*, and regarded them as a link between *Tivelina* and *Meretrix*. More recent scrutiny of the specimens then sent me by M. Cossmann, and the

removal of some adherent sand in order to expose their pedal scars, has induced me to change my opinion so far as the relationship to *Meretrix* is concerned.

I find that in both species the pedal scar is small and separate from that of the adductor, a feature which is not found in any Meretricine genus except *Circe*. The cardinal teeth, being straight, separate, and nearly equally divergent, also resemble those of *Circe* (especially of *Gouldia*) quite as much as they do those of *Meretrix*; but *Meretrissa* differs from both in exhibiting a small pallial sinus which is more than a mere inflection of the pallial line, though it is not deep.

Further, since *Circe*, in the forms of *Circenita* and *Gouldia*, co-existed with *Tivolina*, while *Meretrix* has not been found in any of the European Tertiaries, I now consider *Meretrissa* to be more closely allied to *Circe* than to *Meretrix*. It may be regarded as a link between *Tivolina* and *Circenita*, but, as the internal features resemble the latter more than the former, I group it here as a sub-genus of *Circe*.

Shell small, sub-trigonal, nearly smooth, compressed. Hinge weak with three divergent cardinals, the anterior of the right valve pointing to the anterior lateral pit, the median grooved, and the posterior entire. Pallial line with a short rounded sinus. Pedal scar separate from adductor.

Genus MERETRIX, Lamarck, 1799.

This genus is very distinct both in general form and in dentition from all the preceding genera, and it is, therefore, far from being a good type of the sub-family to which it gives its name. The species of which it consists are few, and they are restricted to the Indian and Chinese seas, extending from Aden and the Gulf of Oman to Timor and the Philippines, and as far north as Japan; but I have not been able to find any record of its occurrence in Australian waters, nor in the Pacific Ocean, nor have I been able to ascertain how far it reaches southward along the east coast of Africa, but it does not exist in Natal or Cape Colony.¹

Moreover, it appears to be of comparatively recent origin, for it does not occur in any of the Tertiary faunas of Europe, neither can I find that any ancestral form has been described from those of India or Burmah. At present, therefore, it seems impossible to say when or where it originated, but its distribution suggests that its centre of dispersal was either from Siam or the Malay Archipelago, for most of the species are found in that region.

¹ *Meretrix lusoria* has been recorded from Natal by Mr. G. B. Sowerby (Journ. Conch., 1894, p. 377), but he subsequently found that it was really a species of *Tivela*, and in his Appendix to *Marine Shells of South Africa*, published in 1897, he described the species under the name of *Tivela alucinans*. In 1903 (Proc. Malac. Soc., vol. v) Mr. E. A. Smith identified it with *Tivela natalensis* of Dunker, and he informs me that it was by mistake that the name of *Meretrix zonaria* was included in the same list, the shell being really *T. natalensis*.

I hope that palæontologists will give heed to the facts above mentioned, and will not continue to record *Meretrix* from Cretaceous or Tertiary deposits when they only mean some species of '*Cytherea*' in its widest sense, which they cannot determine more precisely from the external characters. In most cases it would be better to record it as *Callista* (?), or else to continue the use of the name *Cytherea* for indeterminate fossil forms.

Synonyms: *Cytherea*, Lam., 1805; *Nympha*, Mörch, 1853.

Type, *Venus meretrix*, Linn.

Shell oval or trigonal, sub-equilateral, thick, generally smooth, but sometimes concentrically lirate, with a verrucose periostracum and a minute oblique striation on the posterior slope. Neither lunule nor escutcheon is clearly defined. Ligament rather short and very prominent on strong elevated nymphs. Hinge-plate thick, with three separate cardinals in each valve diverging from a point beneath the umbo; left posterior confluent with the nymph, right posterior narrow and superficially grooved, others entire. Lateral teeth strong. Both nymphs are corrugated. Ventral margins smooth. Pallial line with a small and shallow sinus. Pedal scar confluent with that of adductor.

The species are not very numerous, as most of those which have received distinctive names are only colour varieties of *M. meretrix*, but I should recognize the following as distinct species—*petechialis*, Lam., *lusoria*, Chem. (= *formosa*, Sow.), *lamarecki*, Hanley, *lyrata*, Sow., and *exilis*, Desh.

GENUS *TIVELA*, Link, 1807.

Synonyms: *Trigona*, Megerle, 1811; *Trigonella*, Conrad, 1837.

Shell trigonal, sub-equilateral, solid, smooth, with a more or less deciduous periostracum. Lunule long, but faintly circumscribed. Escutcheon not defined. Ligament very short, prominent, based on thick nymphal plates. Cardinal part of the hinge short and triangular, anterior part elongated. Cardinal teeth 3-3, all narrow and entire, except the left median, which is sometimes grooved; the left anterior points to the elongate anterior lateral, and the right anterior is close to the lunular margin. Nymphs strongly corrugated, and sometimes divided into a series of ridges which occupy part of the hinge-plate, and simulate supplementary teeth. Dorsal margins grooved as in *Callista*, etc. Ventral margins smooth. Pedal scar very long and confluent with that of the adductor.

Tivela, s.s. Type, *Venus corbicula*, Gmel. (= *V. mactroides*, Born). Ventral margins smooth.

Eutivela, Dall, 1891. Type, *T. perplexa*, Stearns.

Ventral margins crenulated. Only known from Brazil.

Sub-genus.

Grateloupia, Desmoulins, 1828. Type, *Donax irregularis*, Bast.

Synonym: *Cytheriopsis*, Conrad, 1833.

Shell like *Tivela*, but with a number of oblique parallel ridges on the nymphs, and sometimes a thickening on the posterior dorsal

margin which simulates a posterior lateral tooth. Species occur in the Eocene of America and the Miocene of Europe, and in the latter they are associated with a true *Tirela*.

The hinge of *Tirela* has been fully described by me in a previous communication,¹ in which I showed that the normal teeth are always present, though they are often crowded into the anterior half of the hinge-plate by the great development of the nymphal plates. The relationship of *Grateloupia* was discussed in the same paper.

Genus ANTIGONA, Schumacher, 1817.

This genus comprises the shells which Gray regarded as the typical group of the *Venus* of Lamarck, taking the type to be *Venus verrucosa*, but not himself designating it as such.² In this view he was followed by Deshayes (1853) and the Adams (1857), and they all included the genus in the sub-family which possesses an anterior lateral tooth. Römer, however, in 1867 introduced confusion by regarding the group as part of the genus *Chione*, not even distinguishing it as a separate section, but grouping the species in the same section as the typical *Chione* under the name of *Omphalocladrum*. Paul Fischer (in 1887) adopted Römer's method of classification, and most French geologists have followed in his footsteps, so that even such conchologists as Cossmann and Peyrot include the *Antigona* group under a comprehensive *Chione* genus, though they do separate it as a section under Möreh's name.

In America Dr. Dall has followed the English view of complete generic distinction, and has placed the two genera in separate sub-families. Unfortunately, however, he has revived the abandoned name of *Cytherea* from Bolten's catalogue, and has applied it to this genus with *V. puerpera* as a type. Hence, though agreeing with his recognition of the genus, I cannot accept his nomenclature.

Of course, the whole question of generic difference depends upon the structural importance of the small tooth on the front part of the hinge-plate. Römer must have regarded it as a mere exerescence, and not as a definite anterior lateral, though how he could possibly hold such a view with regard to *Ant. lamellaris* (= *A. lamarki*, Gray) is really incomprehensible. The fact is that different species of *Antigona* show every gradation between the well-developed laterals of *A. lamellaris* (in both valves) and the little pustular tooth in the left valve of *A. reticulata*, which looks like an outgrowth from the anterior cardinal and has no corresponding pit in the right valve. Yet comparison with other species shows that the pustule is undoubtedly an atrophied anterior lateral, apparently in process of being crowded out by a shortening of the hinge-plate and the greater development of the anterior cardinal.

It may, of course, be argued that the *Chione* group has been evolved

¹ Proc. Malac. Soc., vol. x, p. 266, 1913.

² See my discussion of the name *Venus* in Proc. Malac. Soc., vol. ix, p. 242, 1911.

from *Antigona* by the gradual elimination of the anterior laterals, and I am quite disposed to think that such has been its origin; but our genera are established for the sake of convenience in classification, and not for the purpose of expressing a theory. There is no difficulty in distinguishing the two groups and in recognizing them as genera, and they have certainly had a separate existence ever since the Miocene period. In the recent forms the anterior lateral is persistent from youth to full age, and if there are fossil forms in which it disappears with growth, they must be allocated on the sum of their other characters, but I do not know of any.

Here I must correct an error into which I fell in 1908 when describing the Veneridæ of the Eocene and Oligocene deposits. An Oligocene shell described by M. St. Meunier under the name of *Venus loewyi*¹ was then ascribed to the genus *Chione*, because M. Cossmann had referred it to that genus, and because reference to the published figures seemed to show that such reference was correct. Recently, however, by the publication of MM. Cossmann & Peyrot's *Conchyliologie Néogénique de l'Aquitaine*, I became aware that their genus *Chione* was the antiquated conception of Römer, and that it included the groups of *Clausina*, *Omphaloclathrum*, etc. In reply to inquiry M. Cossmann informs me that his valves of *Venus loewyi* show a distinct anterior lateral tooth in the left valve and a pit for its reception in the right. It is clear, therefore, that the shell is a species of *Antigona*, and does not belong to *Chione*; it follows, moreover, that *Antigona* dates from the Oligocene period, and that *Chione* does not, so far as we yet know.

It may also be stated that the *Ventricoloidea* of Sacco (1900)² appears to be a synonym of *Artena*, Conrad (1870).³ The type of the former is *Cytherea multilamella*, Lam., and having compared specimens of this shell, which I owe to the kindness of Professor Peyrot, with the descriptions and figures of *Artena* given by Dr. Dall, I have no hesitation in saying that it accords with *Artena* in all essential particulars. As Dr. Dall remarks, *Artena* bears the same relation to the typical *Antigona* (*A. lamellaris*) as *Ventricola* does to the group which he calls *Cytherea* (i.e. *A. puerpera*), and this I understand to be exactly the idea which Professor Sacco wished to express.

It is unfortunate that the genotype of *Antigona* (*V. lamellaris*, Schum.) is so different from all the other recent members of the genus that it stands by itself. It is one of the absurd results created by the plan of fixing genera by 'types', and by the rigid rule of priority that the so-called typical section of a large genus may include only one species! This, however, makes no difference to the definition of the genus as a whole, and I therefore give such a description before indicating the various divisions of it.

¹ Nouv. Arch. Mus. d'Hist. Nat. Paris, sér. II, tom. iii, p. 235, pl. xiii, figs. 11, 12.

² I Moll. Terz. Piem., pt. xxviii, p. 30, 1900.

³ Amer. Journ. Conch., vol. vi, p. 76.

ANTIGONA, Schum., 1817.

Synonyms: *Dosina*, Gray, 1838; *Venus*, s.s., Gray, 1847, and Deshayes, 1853; *Omphaloclathrum*, Mörch, 1853; *Venus* (*Antigona*), E. A. Smith, 1885 (Challenger Report); *Cytherea*, Dall (after Bolten), 1902.

Shell convex and generally globose, with prominent concentric lamellæ and sometimes with radial sculpture. Lunule and escutcheon both clearly defined. Umbones prominent and incurved. Inner margins crenate. Hinge thick and teeth strong; each valve with three divergent cardinals, of which three are grooved, and the posterior of the left valve is confluent in the nymph. The anterior lateral of the left valve is often small and papillose, and those of the right are obsolete. Pallial sinus short, either angular or rounded. Pedal scar generally separate from that of the adductor.

Antigona, s.s. Type, *Cytherea lamellaris*, Schum.

Shell oval, with strong concentric lamellæ, crossed by radial riblets. Lunule impressed, and escutcheon defined in both valves. Ligament exposed. Teeth widely divergent, and both anterior cardinals directed forward; a strong anterior lateral in the left, and two small ones in the right valve. Nymphs long and striated. Pallial sinus small and acutely angular.

Artena, Conrad, 1870 (= *Ventricoloidea*, Sacco, 1900). Type, *Venus straminea*, Conrad, 1842 (not of Conrad, 1837).

Shell oval, globose, with sharp concentric lamellæ, and striated interspaces, but no radial ribs. Left anterior lateral well developed, and two strong laterals in the right valve with a long, deep pit between them. Other teeth normal. Pallial sinus small and angular.

The type is an American Miocene fossil. European species are *Venus loewyi*, Meun. (Oligocene), *Cytherea multilamella*, Lam. (Miocene and Pliocene), *Venus burdigalensis*, Mayer (Miocene).

Sub genera.

Periglypta.¹ J.-Br., 1914 (= *Cytherea*, s.s., Bolten in Dall). Type, *Venus puerpera*, Linn.

Shell cancellated by strong concentric ridges crossed by radial riblets which crenulate the ridges. Escutcheon narrow, and the right half overlapping the left. Ligament deeply sunk. Nymphs usually having a finely rugose area. Anterior lateral very small and close to the anterior cardinal. Pallial sinus usually wide and rounded.

This group includes the following species which are currently known as '*Venus*': *V. reticulata*, Linn., *V. crispata*, Desh., *V. listeri*, Gray (W. Indies), *V. clathrata*, Desh., *V. sowerbyi*, Desh. (E. Indies), *V. multicostata*, Sow., and *V. monilifera*, Sow. The forms known as *lacerata*, Hanley, *magnifica*, Hanley, and *reticulata*, Sow., are probably only varieties of *puerpera*. Two other species, *V. laqueata*, Sow., and *V. chemnitzii*, Hanley, differ from all the rest in the following

¹ From *περι*, very much; *γλυπτος*, carved.

particulars: they have smooth nymphs, a small angular sinus, and the pedal scar is confluent with that of the adductor.

Clausina, Brown, 1827. Type, *Venus verrucosa*, Linn.

Shell oval or rotund, globose or compressed, with dominant concentric structure. Lunule and esutcheon well defined, the latter being unequally divided between the valves. Teeth less widely divergent than in *Periglypta*, but normal, except that the anterior lateral is small. Nymphs smooth. Pallial sinus always small and angular.

Clausina, s.s. Inflated and often globose, concentric ridges crossed by irregular radial riblets which sometimes become nodular prominences. Left anterior lateral very small and pustular; right laterals and pit often becoming obsolete. Pedal scar large, oval and separate from adductor scar.

Only a few species can be included in this group, viz., *V. verrucosa*, Linn. (with the vars. *canariensis* and *rosalina*), *V. nodulosa*, Sow., *V. toreuma*, Gould, *V. jukesi*, Desh., and *V. fordii*, Dall.

Ventricola, Römer, 1857. Type, *Venus rigida*, Dillw. (= *rugosa*, Chem.).

Shell globose or merely convex, ornamented with numerous regular concentric lamellæ with striated interspaces and sometimes weak radial striæ on the posterior slope. Anterior denticle and its corresponding pit both persistent. Pedal scar confluent or opening by a channel into the adductor scar.

This group includes *V. casina*, Linn., *V. foveolata*, Sow., *V. oblonga*, Hanley, *V. declivis*, Sow., *V. lyra*, Sow., *V. effossa*, Phil., *V. strigillina*, Dall, *V. magdalena*, Dall, *V. rugatina*, Heilprin (if not vars. of *rigida*).

Circomphalus, Mörch, 1853. Type, *V. plicata*, Gmel. (fixed by Sacco, 1900).

Shell compressed with flattened umbones, encircled by distinct concentric lamellæ which pass posteriorly into expanded elevations. Hinge-plate much curved and attenuated posteriorly. Anterior lateral very small and often impersistent; pit in the right valve obsolete. Pedal scar rather small, nearly separate, but connected with the adductor scar by a narrow channel. Valve-margins very finely crenate.

The name *Circomphalus* was adopted by Mörch from Klein, and applied to the following small group of shells: *V. peruviana*, Sow., *V. dysera*, Linn. (= *plicata*, Gmel.), *V. calophylla*, Phil., *V. tiara*, Dillw., and *V. berryi*, Gray. In 1857 the Messrs. Adams also adopted it for the same group, and included many other species allied to *V. tiara*, but without indicating any one as a type. In the same year Römer proposed the name *Anaitis* for what was practically the same group, but this name was preoccupied by Duponchel in 1829, and cannot therefore be used.

No one seems to have selected a type for *Circomphalus* until 1900, when Professor Sacco definitely indicated *V. plicata*, Gmelin, as the type of a small group including *V. lamellata* and *V. calophylla*, but without giving any diagnosis, merely remarking that its members were species which could not be referred to other sub-genera such as

Chione, *Clausinella*, and *Anaitis*.¹ In 1902 Dr. Dall gave *V. plicata* as the type of *Circomphalus*, but without reference to Sacco or to anyone else in explanation of such a selection.²

It is much to be regretted that the name should thus come to be attached to *V. plicata* instead of to some member of the *tiara* group, for which it was evidently intended both by Mörch and by H. & A. Adams. They only included *V. plicata* in that group because they supposed it to resemble the rest in having no lateral teeth, or because they did not regard the small anterior tubercle as a normal tooth.

Neither *V. lamellata* nor *V. calophylla* can be grouped with *V. plicata*, for neither of them shows any trace of an anterior lateral even in very young shells, and through the kindness of Dr. J. C. Verco, of Adelaide (S.A.), I have been able to examine young shells of both these species. Another shell which much resembles *V. plicata* in external characters is *V. yatesi*, but the specimens which I have seen show no trace of an anterior denticle. Indeed, so far as I can ascertain there is no other recent species which can be associated with the type of *Circomphalus*. There are, however, several species in the Miocene and Pliocene deposits of France, Italy, and Austria which certainly belong to it; these are *V. subplicata*, d'Orb., *V. basteroti*, Desh., *V. dertoparra*, Sacco, and *V. scalaris*, Bronn. By Messrs. Cossmann and Peyrot these species have been referred to the *Clausinella* section of *Chione*, but that must be reserved for the shells which have no rudiment of a lateral tooth, as there is none in *C. fasciata* which is the type. The other species which they associate with *V. plicata* I should refer to *Ventricola*; these are *V. casinoides*, *V. fasciculata*, and *V. haidingeri*. Professor Sacco has figured many varieties of the above-mentioned species, but I do not think he has correctly referred all his specimens to their proper species, for he evidently regards the anterior denticle as of no importance even in the distinction of species.

I am quite prepared to admit that the *fasciata* and *tiara* group has probably been derived from the *plicata* group by the elimination of this anterior lateral, but I regard the retention of the lateral tooth as a feature of generic importance. This question will be further discussed in the sequel.

¹ I Moll. Terz. Piem., pt. xxviii, 1900.

² Proc. U.S. Nat. Mus., vol. xxvi, p. 356, 1902.